

COVID-19 Outcomes Among People With HIV and COVID-19 in New York City

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Background. Literature on the impact of human immunodeficiency virus (HIV) on coronavirus disease 2019 (COVID-19)-related outcomes remains mixed. Few studies have evaluated COVID-19 outcomes by HIV status using population-based data.

Methods. Using data from New York City COVID-19 surveillance and HIV surveillance systems prior to the widespread availability of COVID-19 vaccines, we conducted a retrospective cohort study comparing the risk of COVID-19 hospitalization and mortality by HIV status among severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) diagnoses from 29 February to 17 October 2020.

Results. Risk of hospitalization and death among people with HIV (PWH) with COVID-19 were both nearly 30% higher compared with people without HIV. In crude models, incidence of adverse COVID-19 outcomes among PWH compared to people without HIV was elevated in certain groups, including women, and black, Hispanic/Latino, Native American, and multiracial people. CD4 cell count at SARS-CoV-2 diagnosis and presence of an underlying, non-HIV-related condition were independently and strongly associated with risk for COVID-19 hospitalization and death among PWH.

Conclusions. New Yorkers with HIV experienced elevated risk for poor COVID-19 outcomes compared to those without HIV during 2020. PWH, particularly those with low CD4 counts or underlying conditions, should be an ongoing focus for COVID-19 vaccination and rigorous identification and treatment of SARS-CoV-2 infections to prevent adverse outcomes.

Keywords. COVID-19; HIV; hospitalization; mortality; population-level surveillance.

Older age, immune suppression, male sex, and coexisting medical conditions have been identified as risk factors for poor clinical outcomes after diagnosis with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection [1–5]. People with HIV (PWH) are aging and, in the United States, older compared with the general population; medical comorbidities and history of immunodeficiency are common among PWH [6–9]. In addition, PWH face sociostructural barriers linked to poor health and to adverse coronavirus disease 2019 (COVID-19)-related outcomes, including racism, poverty, lack of consistent access to high-quality health care, unstable housing, and food insecurity [10, 11]. Given health-related and social vulnerabilities experienced by PWH, concern about the co-occurrence of human immunodeficiency virus (HIV) and SARS-CoV-2 infection, and in particular the risk of adverse COVID-19 outcomes among PWH, has persisted [12].

To date, literature on the impact of HIV on COVID-19-related clinical outcomes remains mixed [13]. Some studies have found that COVID-19 outcomes, including hospitalization and death, are comparable between PWH and people without HIV (PWOH) [14–17]; others suggest a link between HIV status and poor outcomes [18–22]. Differences in study populations, including whether clinical cohort or population based, in study methodology, including time period analyzed, sample size, and adjustment for other important factors such as comorbidities, and associated biases [23], may explain the mixed evidence base. Nonetheless, further examination of the association between HIV and COVID-19 outcomes is needed, particularly at the population level, to inform prevention and treatment for people with HIV and drive ongoing efforts to improve COVID-19 vaccination coverage in this population. Population-level data, such as those from surveillance, enable a more valid assessment of COVID-19 severity among PWH because they include all PWH regardless of HIV care or viral suppression status.

New York City (NYC) has a long-standing HIV epidemic, with an estimated 84 700 PWH in 2020 [24]. NYC was an early epicenter of the COVID-19 epidemic in the United States, with a first wave that peaked at >6000 daily cases in April 2020, and a cumulative total of 3 170 895 confirmed and probable cases reported as of 13 January 2023 [25]. In a previous population-level descriptive analysis of HIV and SARS-CoV-2 surveillance data in NYC, we identified a prevalence of diagnosed HIV

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infection of 1.06% among NYC COVID-19 cases reported through 2 June 2020 [26]. That analysis also suggested that adverse COVID-19–related outcomes, including hospitalization, intensive care unit admission, and death, were more common among PWH than PWOH, and that severity of outcomes was pronounced among PWH with lower CD4 cell counts. Here we report on a combined analysis of NYC HIV and COVID-19 surveillance data through December 2020 (prior to widespread COVID-19 vaccine availability) on incidence of hospitalization and death by HIV status.

METHODS

Study Design and Population

We conducted a retrospective cohort study from 29 February 2020 through 17 October 2020, comparing the risk of COVID-19 hospitalization and mortality by HIV status among NYC residents aged 13 years and older with confirmed COVID-19 diagnosis, determined by positive nucleic acid amplification test for SARS-CoV-2. COVID-19–related outcomes were assessed through 16 December 2020.

Data Sources

Data sources included the NYC Department of Health and Mental Hygiene’s (DOHMH) HIV surveillance registry and COVID-19 surveillance system. DOHMH is authorized by state and local law to collect clinical and laboratory information on HIV and COVID-19 for public health surveillance. Individual patient confidentiality for people whose information is maintained in the registries is protected by state and local public health law.

The HIV surveillance registry contains records for people diagnosed in NYC and reported to NYC DOHMH with HIV infection (since 2000) or AIDS (since 1981). Providers are required to report all new diagnoses of HIV and AIDS, and laboratories are required to report all positive HIV diagnostic test algorithms, viral load test results, CD4 test results, and the nucleotide sequence generated during HIV genotypic resistance testing ordered by NYC providers or for NYC residents. Sociodemographic information in the registry includes age, sex at birth, race/ethnicity, and residential address, which are derived from patients’ medical charts (recorded by the provider and/or collected from the patient directly), and laboratory test results.

Results of molecular-based diagnostic testing for SARS-CoV-2 have been reportable to DOHMH since March 2020. Test result data are received via electronic laboratory reporting and include basic patient identifying and demographic information. Supplemental demographic (eg, sex at birth, race/ethnicity) and clinical information, including hospitalization history, is extracted, when available, from multiple sources, including patients’ medical records, patient interviews, death

certificates, and from matches with other disease surveillance registries maintained by DOHMH. Information on previously diagnosed underlying conditions among COVID-19 cases is captured when available, including asthma, cancer, diabetes, hepatic disease, heart disease, hypertension, immunodeficiency, kidney disease, lung disease, and other conditions.

Information on deaths attributed to SARS-CoV-2 infection is collected through routine linkage with population-level mortality data from the DOHMH Office of Vital Statistics. This analysis included only “confirmed” COVID-19 deaths, or people with a positive molecular-based diagnostic test for SARS-CoV-2 with COVID-19 as underlying cause of death.

Registry Matching Methods

COVID-19 case data reported to DOHMH as of 17 October 2020 were matched against HIV surveillance data on 4 December 2020, using a 36-key deterministic algorithm [27]. Surveillance data on COVID-19 hospitalizations and deaths through 16 December 2020 were linked to the matched HIV and COVID-19 cases to generate the analytic dataset.

Measures

Outcomes included (1) COVID-19 hospitalization, defined as hospitalization within 14 days prior to or after the date of COVID-19 diagnosis; and (2) COVID-19 mortality, defined as death within 60 days following COVID-19 diagnosis. The main exposure was HIV status. The exposed cohort included people diagnosed with HIV who were reported to the NYC DOHMH prior to their COVID-19 diagnosis. Covariates in the main model included age at COVID-19 diagnosis (categorized as 13–17, 18–44, 45–64, 65–74, ≥ 75 years); sex at birth; and presence of ≥ 1 known underlying condition (categorized as asthma, cancer, diabetes, hepatic disease, heart disease, hypertension, kidney disease, lung disease, non-HIV immunodeficiency, or other specified condition). Race/ethnicity was excluded as a covariate from the main model due to missingness among PWOH, for whom the sole source of covariate data was the COVID-19 surveillance database.

In the model restricted to PWH, primary exposure was baseline CD4 cell count (categorized as <200 , 200–349, 350–499, 500 + cells/ μL). Additional covariates included race/ethnicity and baseline HIV viral suppression (defined as viral load <200 copies/mL). Baseline CD4 count and viral suppression were determined based on laboratory results closest to and no more than 6 months prior to COVID-19 diagnosis. PWH were included in the model only if they had data available on both baseline viral suppression and CD4 count.

Statistical Analysis

Follow-up time for COVID-19 hospitalization was 14 days following COVID-19 diagnosis, from 29 February to 31 October 2020. For hospitalized cases missing date of hospitalization,

discharge date, and diagnosis date were used to impute hospitalization date. Follow-up time for COVID-19 death was from date of COVID-19 diagnosis until 60 days following, from 29 February to 16 December 2020. COVID-19 cases with no reported date of death were censored as of 16 December 2020.

Matched COVID-19 surveillance and HIV registry data were used to calculate incidence rates (IR) per 1000 person-days (PD) of COVID-19 hospitalization and mortality, by HIV status. Incidence rates for COVID-19 hospitalization and mortality were calculated within strata of sex, age at COVID-19 diagnosis, NYC borough of residence, race/ethnicity, presence of known underlying condition, and neighborhood-level poverty. Neighborhood-level poverty was defined as percentage of residents within a ZIP code with household incomes <100% of the federal poverty level, per the American Community Survey 2013–2017 (categorized as low, < 10%; medium, 10%–19.9%; high, 20%–29.9%; very high, \geq 30%), produced by DOHMH using US Census Bureau Population Estimate Program files (unpublished data, NYC DOHMH, 2020). Among PWH, IR were also calculated for COVID-19 hospitalization and mortality by baseline CD4 count and HIV viral suppression. Incidence rate ratios (IRR) were calculated to compare COVID-19 hospitalization and mortality between PWH and PWOH, overall and by demographic and clinical characteristics.

We ran Kaplan-Meier curves with log-rank tests to examine the association between covariates and COVID-19 hospitalization and death (data not shown). Statistically significant (at $P < .05$) and clinically relevant covariates were included in separate Cox proportional hazards regression models to estimate the association between HIV status and COVID-19 hospitalization and mortality. Both models included adjustment for age at COVID-19 diagnosis, sex at birth, and presence of \geq 1 known underlying condition. We ran separate Cox regression models among only PWH with COVID-19 to estimate the association between baseline CD4 count and COVID-19 hospitalization and mortality, adjusting for age at COVID-19 diagnosis, sex at birth, race/ethnicity, presence of \geq 1 known underlying condition, and baseline HIV viral suppression. Adjusted hazard rates (aHR) and 95% confidence intervals (CI) are presented for all models.

Statistical analyses were conducted using SAS (version 9.4; SAS Institute).

RESULTS

The study population included 248 678 COVID-19 cases among NYC residents from 29 February to 17 October 2020 (Table 1). Of all COVID-19 cases, 2854 occurred among PWH and 245 824 among PWOH. Compared to PWOH, a higher proportion of COVID-19 cases among PWH were male, aged 45–64 years, of black or Hispanic/Latino race/

ethnicity, resided in the Bronx or Manhattan, resided in neighborhoods of very high poverty, and had \geq 1 non-immunodeficiency-related underlying condition.

Among PWH COVID-19 cases, 84% were virally suppressed and 49% had a CD4 count of \geq 500 cells/ μ L at baseline (Table 1). Fifty-eight percent of PWH COVID-19 cases had \geq 1 underlying condition documented; heart disease (28%), diabetes (26%), hypertension (24%), and hepatic disease (24%) were most common.

As of 16 December 2020, there were 58 317 COVID-19 hospitalizations recorded for the study population. Among PWH COVID-19 cases in the cohort, there were 1118 hospitalizations during 26 395 PD (IR, 42/1000 PD) (Table 2). Among PWOH COVID-19 cases, there were 57 199 hospitalizations during 2 737 269 PD (IR, 21/1000 PD). The crude IRR comparing COVID-19 hospitalizations among PWH to PWOH was 2.03. Rate ratios comparing incidence of COVID-19 hospitalization among PWH with their PWOH counterparts were highest for women (IRR, 2.50), those aged 18–44 (IRR, 2.22) or 45–64 years (IRR, 2.23) at COVID-19 diagnosis, Bronx residents (IRR, 2.21), black (IRR, 1.55) and Hispanic/Latino people (IRR, 1.46), and those living in NYC ZIP codes at the lowest poverty level (IRR, 2.37). Incidence of hospitalization among PWH with at least 1 underlying condition was only slightly elevated compared to PWOH (IRR, 1.22). Among PWH with COVID-19, those with <200 CD4 cells/ μ L had the highest incidence of hospitalization (IR, 111.06/1000 PD). Incidence of hospitalization among PWH did not vary appreciably with baseline HIV viral suppression status.

As of 16 December 2020, there were 18 767 confirmed COVID-19 deaths in the study population. Among PWH COVID-19 cases there were 341 deaths during 155 684 PD (IR, 2.19/1000 PD), and among PWOH COVID-19 cases there were 18 426 deaths during 13 873 023 PD (IR, 1.33/1000 PD) (Table 3). The crude IRR of COVID-19 deaths among PWH compared to PWOH was 1.65. Rate ratios comparing incidence of COVID-19 death among PWH with their PWOH counterparts were highest among women (IRR, 2.23), those aged 18–44 years at COVID-19 diagnosis (IRR, 3.88), Staten Island residents (IRR, 2.56), Native American or multiracial (IRR, 1.39) and Hispanic/Latino people (IRR, 1.31), and those living in very high-poverty NYC ZIP codes (IRR, 2.40). Incidence of death among PWH with \geq 1 underlying condition was not elevated compared to PWOH (IRR, 1.01). Among PWH with COVID-19, those with <200 CD4 cells/ μ L experienced the highest incidence of death (IR, 5.03/1000 PD). Incidence of death among PWH did not vary appreciably with baseline HIV viral suppression status.

After adjusting for sex, age at COVID-19 diagnosis, and presence of at least 1 non-HIV-related underlying condition, the risk of COVID-19-related hospitalization was nearly 30% higher among PWH compared to PWOH (aHR, 1.28; 95%

Table 1. Confirmed COVID-19 Cases, Hospitalizations, and Deaths by Diagnosed HIV Status—29 February to 16 December 2020, New York City

Characteristic	All NYC COVID-19 Cases				COVID-19–Related Hospitalizations ^a				COVID-19–Related Deaths ^b			
	PWH		PWOH		PWH		PWOH		PWH		PWOH	
	N	(%)	N	(%)	n	(%)	n	(%)	n	(%)	n	(%)
Total	2854	(100)	245 824	(100)	1118	(100)	57 199	(100)	341	(100)	18 426	(100)
Sex at birth												
Female	796	(28)	121 256	(49)	328	(29)	25 428	(44)	103	(30)	7405	(40)
Male	2053	(72)	124 191	(51)	789	(71)	31 755	(56)	238	(70)	11 019	(60)
Missing	5	(0)	377	(<1)	1	(0)	16	(<1)	0	(0)	2	(0)
Age at COVID-19 diagnosis, y												
13–17	2	(0.1)	9919	(4)	0	(0)	704	(1)	0	(0)	14	(0)
18–44	733	(26)	96 145	(39)	150	(13)	9836	(17)	20	(6)	688	(4)
45–64	1530	(54)	84 573	(34)	607	(54)	18 540	(32)	157	(46)	4005	(22)
65–74	441	(15)	28 277	(12)	252	(23)	12 373	(22)	103	(30)	4543	(25)
75+	147	(5)	26 419	(11)	109	(10)	15 745	(28)	61	(18)	9175	(50)
Missing	1	(0)	491	(<1)	0	(0)	1	(0)	0	(0)	1	(0)
NYC borough of residence												
Bronx	954	(33)	53 436	(22)	396	(35)	12 374	(22)	131	(38)	3787	(21)
Brooklyn	663	(23)	70 613	(29)	264	(24)	16 445	(29)	86	(25)	5538	(30)
Manhattan	642	(22)	31 831	(13)	251	(22)	8052	(14)	66	(19)	2391	(13)
Queens	518	(18)	73 660	(30)	180	(16)	17 832	(31)	48	(14)	5836	(32)
Staten Island	77	(3)	16 284	(7)	27	(2)	2496	(4)	10	(3)	874	(5)
Race/ethnicity												
Black, non-Hispanic/Latino	1065	(37)	37 307	(15)	559	(50)	15 051	(26)	170	(50)	5070	(28)
Hispanic/Latino	764	(27)	49 740	(20)	335	(30)	16 797	(29)	112	(33)	5673	(31)
White, non-Hispanic/Latino	295	(10)	40 214	(16)	104	(9)	11 993	(21)	38	(11)	4725	(26)
Asian, Pacific Islander	34	(1)	11 421	(5)	11	(1)	3872	(7)	2	(1)	1411	(8)
Native American or multiracial	29	(1)	2078	(1)	22	(2)	1331	(2)	15	(4)	893	(5)
Unknown	667	(23)	105 064	(43)	87	(8)	8155	(14)	4	(1)	654	(4)
Area-based poverty level ^c												
Low, <10% below FPL	245	(9)	38 461	(16)	92	(8)	7540	(13)	24	(7)	2562	(14)
Medium, 10% to <20% below FPL	975	(34)	101 076	(41)	357	(32)	23 775	(42)	92	(27)	8030	(44)
High, 20% to <30% below FPL	728	(26)	60 816	(25)	300	(27)	15 796	(28)	85	(25)	4959	(27)
Very high, 30%+ below FPL	863	(30)	39 181	(16)	364	(33)	9635	(17)	140	(41)	2842	(15)
Poverty level not available	43	(2)	6290	(3)	5	(0)	453	(1)	0	(0)	33	(<1)
At least 1 underlying condition ^d	1645	(58)	86 085	(35)	918	(82)	42 777	(75)	312	(91)	16 074	(87)
Asthma	127	(4)	5947	(2)	97	(9)	3605	(6)	33	(10)	1099	(6)
Cancer	277	(10)	10 035	(4)	163	(15)	5137	(9)	67	(20)	2234	(12)
Diabetes	731	(26)	42 875	(17)	459	(41)	23 389	(41)	187	(55)	9387	(51)
Hepatic disease	692	(24)	7925	(3)	360	(32)	3970	(7)	119	(35)	1581	(9)
Heart disease	812	(28)	41 428	(17)	583	(52)	28 214	(49)	218	(64)	12 151	(66)
Hypertension	673	(24)	34 402	(14)	483	(43)	23 102	(40)	185	(54)	9686	(53)
Kidney disease	311	(11)	9598	(4)	257	(23)	8258	(14)	104	(30)	4031	(22)
Lung disease	391	(14)	14 400	(6)	286	(26)	8726	(15)	100	(29)	3295	(18)
Other condition	564	(20)	28 332	(12)	440	(39)	20 683	(36)	147	(43)	7816	(42)
Non-HIV immunodeficiency	NA	NA	5595	(2)	NA	NA	4143	(7)	NA	NA	1206	(7)
Baseline HIV viral suppression status ^e												
Virally suppressed	2407	(84)	NA	NA	935	(84)	NA	NA	277	(81)	NA	NA
No or unknown viral suppression status	447	(16)	NA	NA	183	(16)	NA	NA	64	(19)	NA	NA
Baseline CD4 cell count, cells/ μ L ^f												
<200	339	(12)	NA	NA	226	(20)	NA	NA	84	(25)	NA	NA
200–349	415	(15)	NA	NA	218	(19)	NA	NA	72	(21)	NA	NA
350–499	452	(16)	NA	NA	199	(18)	NA	NA	52	(15)	NA	NA

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Table 1. Continued

Characteristic	All NYC COVID-19 Cases				COVID-19–Related Hospitalizations ^a				COVID-19–Related Deaths ^b			
	PWH		PWOH		PWH		PWOH		PWH		PWOH	
	N	(%)	N	(%)	n	(%)	n	(%)	n	(%)	n	(%)
≥500	1402	(49)	NA	NA	401	(36)	NA	NA	114	(33)	NA	NA
No CD4 reported	246	(9)	NA	NA	74	(7)	NA	NA	19	(6)	NA	NA

Data sources include the NYC DOHMH HIV surveillance registry, with data as reported by 30 September 2020, and the NYC DOHMH COVID-19 surveillance system, with case data through 17 October 2020 and outcomes data through 16 December 2020. All demographic data, residence data, and underlying condition data for NYC COVID-19 cases are from the COVID-19 surveillance system. HIV-related clinical variables for PWH are from the HIV surveillance registry.

Abbreviations: n, N, number; PWH, people with HIV; PWOH, people without HIV; COVID-19, coronavirus disease 2019; DOHMH, Department of Health and Mental Hygiene; FPL, federal poverty level; HIV, human immunodeficiency virus; NA, not applicable; NYC, New York City.

^aCOVID-19-related hospitalization is defined as hospitalization ± 14 days from the date of COVID-19 diagnosis and present date of admission, discharge, or death (as relevant). Among hospitalized cases missing date of admission, median length of stay was used to estimate date of admission.

^bCOVID-19–related death is defined as death date within 60 days after COVID-19 diagnosis date (includes death dates through 16 December).

^cArea-based poverty level is based on NYC ZIP code of most recent residence, as per the COVID-19 surveillance system.

^dData on underlying conditions come from the COVID-19 surveillance system, and reflect data available from medical records, patient interview, and registry matches. These data are recorded when available and are not complete for all people diagnosed with COVID-19. Information on individual conditions in the table is not mutually exclusive; multiple conditions can be collected for an individual. Percentages for specific conditions are for the number of people with each condition out of total PWH with COVID-19 (n = 2410) or total NYC COVID-19 cases (n = 202 012). Immunodeficiency refers to immune suppression resulting from a range of conditions.

^eViral suppression is based on the most recent HIV viral load at cohort entry, within 6 months. A person was considered virally suppressed if their most recent HIV viral load was <200 copies/mL.

^fBaseline CD4 was based on the most recent CD4 count at cohort entry, within 6 months.

CI, 1.2–1.36; Table 4). The risk of COVID-19–related death was also nearly 30% higher among PWH compared to PWOH after adjustment for sex, age at COVID-19 diagnosis, and presence of at least 1 non-HIV–related underlying condition (aHR, 1.27; 95% CI, 1.14–1.41).

Among PWH, after adjusting for sex, age at COVID-19 diagnosis, presence of ≥ 1 non-HIV–related underlying condition, and race/ethnicity, incidence of both COVID-19–related hospitalization and death increased with lower baseline CD4 count (Table 5). Incidence of COVID-19–related hospitalization was more than 2-fold higher among PWH with CD4 < 200 cells/μL compared to PWH with CD4 ≥ 500 cells/μL (aHR, 2.21; 95% CI, 1.87–2.6). Incidence of COVID-19–related death was also more than 2-fold higher among PWH with CD4 < 200 cells/μL compared to PWH with CD4 ≥ 500 cells/μL (aHR, 2.38; 95% CI, 1.79–3.17).

DISCUSSION

Our population-level analysis of surveillance data on HIV and COVID-19 in NYC from March to December 2020 found that PWH were at increased risk for COVID-19 hospitalization and death. These findings confirm results of an earlier descriptive analysis we conducted using the same data sources [26]. In the univariate analyses, PWH with COVID-19 were twice as likely to be hospitalized as PWOH, and 60% more likely to experience a COVID-19–related death as PWOH. Descriptive analyses suggesting that PWH with COVID-19 had worse clinical outcomes compared to PWOH generated the question of whether these differences were due to existing characteristics of the PWH population rather than HIV itself; PWH are

generally older, have more coexisting medical conditions, and are more frequently people of color, all reflecting communities that have been more severely impacted by COVID-19. After accounting for these characteristics in our analysis, PWH remained at elevated risk for both hospitalization and death (nearly 30% increased risk for each). The magnitude of the increased risk of death from COVID-19 among PWH is similar to that found in several other studies [18, 21, 28]. Relatively few other studies have been conducted among a general, nonhospitalized population including both people with and without HIV [8], and analyses restricted to hospitalized patients likely suffer from collider stratification bias, which can distort causal inferences [23]. Given this, our quantification of the risk of hospitalization among PWH with COVID-19 compared with PWOH with COVID-19 is novel.

In our analysis, the incidence of adverse COVID-19 outcomes among PWH compared to PWOH was elevated in certain groups, including people aged 18–64 (hospitalization); people aged 18–44 (death); women (hospitalization and death); black people (hospitalization); Native American and multiracial people (death); Hispanic/Latino people (hospitalization and death); people living in low-poverty neighborhoods (hospitalization); and people living in high-poverty neighborhoods (death). Many of these findings, including those related to age and race/ethnicity, track with the overall epidemiology of COVID-19 in NYC, which highlights the uneven distribution of COVID-19 and its most severe outcomes among New Yorkers [25]. While COVID-19 death rates increased with age among both PWH and PWOH, our study found a particularly pronounced discrepancy between death rates among PWH aged 18–44 and their same-aged counterparts without

Table 2. Rate of COVID-19–Related Hospitalization Among People Diagnosed With COVID-19, 29 February to 16 December 2020, New York City

Characteristic	COVID-19–Related Hospitalization, ^a People With HIV				COVID-19–Related Hospitalization, ^a People Without HIV				
	N PW ^h With COVID-19 n	(Row %)	PD Among PWH	Rate of Hospitalization per 1000 PD (95% CI)	N PW ^h Without COVID-19 n	(Row %)	PD Among PWO ^h	Rate of Hospitalization per 1000 PD (95% CI)	Incidence Rate Ratio (95% CI)
All hospitalized cases	1118	(39)	26395	42.4 (39.9–44.9)	57199	(23)	2737269	20.9 (20.7–21.1)	2.0 (1.9–2.2)
Sex at birth									
Female	328	(41)	7144	45.9 (41.1–51.0)	25428	(21)	1382736	18.4 (18.2–18.6)	2.5 (2.2–2.8)
Male	789	(38)	19192	41.1 (38.3–44.0)	31755	(26)	1349415	23.5 (23.3–23.8)	1.7 (1.6–1.9)
Missing	1	(20)	59	16.9 (4–118.3)	16	(4)	5118	3.1 (1.8–5.1)	5.4 (7–40.9)
Age at SARS-CoV-2 diagnosis, y									
13–17	0	(0)	28	0.0 (NA)	704	(7)	129873	5.4 (5.0–5.8)	0.0 (NA)
18–44	150	(20)	8427	17.8 (15.1–20.9)	9836	(10)	1225042	8.0 (7.9–8.2)	2.2 (1.9–2.6)
45–64	607	(40)	14097	43.1 (39.7–46.5)	18540	(22)	958984	19.3 (19.1–19.6)	2.2 (2.1–2.4)
65–74	252	(41)	3172	79.4 (69.9–89.4)	12373	(44)	243799	50.8 (49.9–51.6)	1.6 (1.4–1.8)
75+	109	(74)	657	165.9 (136.2–196.9)	15745	(60)	172775	91.1 (89.7–92.5)	1.8 (1.5–2.2)
Missing	0	(0)	14	0.0 (NA)	1	(0)	6796	0.1 (0–1.0)	0.0 (NA)
NYC borough of residence									
Bronx	396	(42)	8602	46.0 (41.6–50.7)	12374	(23)	594424	20.8 (20.5–21.2)	2.2 (2.0–2.4)
Brooklyn	264	(40)	6039	43.7 (38.6–49.2)	16445	(23)	786346	20.9 (20.6–21.2)	2.1 (1.9–2.4)
Manhattan	251	(39)	5927	42.3 (37.3–47.8)	8052	(25)	346297	23.3 (22.7–23.8)	1.8 (1.6–2.1)
Queens	180	(35)	5097	35.3 (30.3–40.8)	17832	(24)	812454	21.9 (21.6–22.3)	1.6 (1.4–1.9)
Staten Island	27	(35)	730	37.0 (24.4–53.6)	2496	(15)	197748	12.6 (12.1–13.1)	2.9 (2.0–4.3)
Race/ethnicity									
Black, non-Hispanic/Latino	559	(52)	8048	69.5 (63.8–75.2)	5051	(40)	335674	44.8 (44.1–45.5)	1.5 (1.4–1.7)
Hispanic/Latino	335	(44)	6660	50.3 (45.1–55.8)	16797	(34)	488074	34.4 (33.9–34.9)	1.5 (1.3–1.6)
White, non-Hispanic/Latino	104	(35)	2896	35.9 (29.3–43.4)	11993	(30)	416899	28.8 (28.3–29.3)	1.2 (1.0–1.5)
Asian, Pacific Islander	11	(32)	339	32.4 (16.2–58.0)	3872	(34)	112628	34.4 (33.3–35.5)	0.9 (5–1.7)
Native American or multiracial	22	(76)	171	128.7 (80.6–190.0)	1331	(64)	12892	103.2 (97.8–108.6)	1.2 (8–1.9)
Unknown	87	(13)	8281	10.4 (8.3–12.8)	8155	(8)	1370949	5.9 (5.8–6.1)	1.8 (1.4–2.2)
Area-based poverty level ^b									
Low, <10% below FPL	92	(38)	2301	40.0 (32.2–48.8)	7540	(20)	447126	16.9 (16.5–17.2)	2.4 (1.9–2.9)
Medium, 10% to <20% below FPL	357	(37)	9309	38.3 (34.5–42.5)	23775	(24)	1123063	21.2 (20.9–21.4)	1.8 (1.6–2.0)
High, 20% to <30% below FPL	300	(41)	6510	46.1 (41.0–51.5)	15796	(26)	655391	24.1 (23.7–24.5)	1.9 (1.7–2.1)
Very high, 30%+ below FPL	364	(42)	7709	47.2 (42.5–52.2)	9635	(25)	429429	22.4 (22.0–22.9)	2.1 (1.9–2.3)
Poverty level not available	5	(12)	566	8.8 (2.9–21.1)	453	(7)	82260	5.5 (5.0–6.0)	1.6 (7–3.9)
At least 1 underlying condition ^c									
Yes	918	(56)	11901	77.1 (72.2–82.1)	42777	(50)	677637	63.1 (62.5–63.7)	1.2 (1.1–1.3)
No known condition	200	(17)	14494	13.8 (12.0–15.8)	14422	(9)	2059632	7.0 (6.9–7.1)	2.0 (1.7–2.3)
Among PWH, baseline HIV viral suppression status ^d									
Virally suppressed	935	(39)	22293	41.9 (39.3–44.7)	NA	NA	NA	NA	...
No or unknown viral suppression	183	(41)	4102	44.6 (38.4–51.4)	NA	NA	NA	NA	...

Table 2. Continued

Characteristic	COVID-19–Related Hospitalization, ^a People With HIV				COVID-19–Related Hospitalization, ^a People Without HIV						
	n	PWH With COVID-19	(Row %)	PD Among PWH	Rate of Hospitalization per 1000 PD (95% CI)	n	PWOH With COVID-19	(Row %)	PD Among PWOH	Rate of Hospitalization per 1000 PD (95% CI)	Incidence Rate Ratio (95% CI)
Among PWH, baseline CD4 cell count, cells/ μ L ^b											
<200	226	339	(67)	2035	111.1 (97.0–125.6)	NA	NA	NA	NA	NA	...
200–349	218	415	(53)	3186	68.4 (59.6–77.8)	NA	NA	NA	NA	NA	...
350–499	199	452	(44)	3834	51.9 (44.9–59.4)	NA	NA	NA	NA	NA	...
500 +	401	1402	(29)	14 785	27.1 (24.5–29.9)	NA	NA	NA	NA	NA	...
Unknown/no CD4 available	74	246	(40)	2555	29.0 (22.7–36.3)	NA	NA	NA	NA	NA	...

Data sources include the NYC DOHMH HIV surveillance registry, with data as reported by 30 September 2020, and the NYC DOHMH COVID-19 surveillance system, with case data through 17 October 2020, and outcomes data through 16 December 2020. All demographic data, residence data, and underlying condition data for NYC COVID-19 cases are from the COVID-19 surveillance system. HIV-related clinical variables for PWH are from the HIV surveillance registry.

Abbreviations: n, N, number; CI, confidence interval; FPL, federal poverty level; HIV, human immunodeficiency virus; NA, not applicable; NYC, New York City; PD, person-days; PWH, people with HIV; PWOH, people without HIV.

^aCOVID-19-related hospitalization is defined as hospitalization \pm 14 days from the date of COVID-19 diagnosis and present date of admission, discharge, or death (as relevant). Among hospitalized cases missing date of admission, median length of stay was used to estimate date of admission.

^bArea-based poverty level is based on NYC ZIP code of most recent residence, per the COVID-19 surveillance system.

^cData on underlying conditions come from the COVID-19 surveillance system, and reflect data available from medical records, patient interview, and registry matches. These data are recorded when available and are not complete for all people diagnosed with COVID-19.

^dViral suppression is based on the most recent HIV viral load at cohort entry, within 6 months. A person is considered virally suppressed if their HIV viral load was <200 copies/mL.

^eBaseline CD4 is based on the most recent CD4 count at cohort entry, within 6 months.

HIV, highlighting the impact of HIV on COVID-19 mortality. Additionally, our apparently divergent findings related to neighborhood poverty level were notable. It is possible that the higher incidence of hospitalization among people living in low-poverty, more affluent NYC neighborhoods reflects better access to health care among this group. A similar dynamic could underlie the higher incidence of death among people living in higher-poverty neighborhoods, with impoverished communities generally having poorer access to health care and limited access to COVID-19–related treatment and services to support recovery and survival. To our knowledge, this is the first publication using population-level data on HIV and COVID-19 prior to the widespread availability of COVID-19 vaccines to identify a higher incidence of COVID-19 hospitalization and death among women with HIV compared to women without HIV. Among PWOH, men had higher rates of both COVID-19 hospitalization and death; however, this relationship was reversed among PWH, among whom women had higher rates of COVID-19 hospitalization and death compared with men. These findings suggest that positive HIV status may play a unique role in driving risk for adverse COVID-19 outcomes among women, perhaps related to social and structural determinants of health including gender discrimination and sexism. These relationships should be explored further.

The vast majority of PWH in this analysis were virally suppressed at COVID-19 diagnosis, and viral suppression status did not affect risk for hospitalization or death. This finding is consistent with some other recent studies among PWH [15], although the hospitalization finding is inconsistent with at least 1 other study [19]. However, we identified 2 other clinical factors—CD4 count and presence of a non-HIV–related underlying condition—with independent and strong associations with risk for COVID-19 hospitalization and death. The role of lower CD4 count in increasing risk of hospitalization and death among PWH has been shown elsewhere [29, 30], and supports the broader evidence base that immune health plays a critical role in preventing negative sequelae from SARS-CoV-2 infection [31, 32].

Our findings have important implications for the care of PWH who are diagnosed with, or are otherwise vulnerable, to COVID-19. Although this analysis was conducted prior to availability of COVID-19 vaccines, its findings underscore that access to vaccination against COVID-19, as well as to oral antivirals for treatment, are particularly important in this population. COVID-19 vaccines have been shown to be highly effective in preventing severe outcomes in the general population [33, 34], including among PWH. Vaccination is especially important for PWH in certain demographic groups, to protect individuals from poor clinical outcomes after SARS-CoV-2 infection and to minimize the effects of gender and racial inequities exacerbated by COVID-19. Vaccination is also critical for PWH with low CD4 count, regardless of current viral

Table 3. Rate of COVID-19–Related Death Among People Diagnosed With COVID-19, 29 February to 16 December 2020, New York City

Characteristic	COVID-19–Related Death, ^a People With HIV				COVID-19–Related Death, ^a People Without HIV					
	n	PWH with COVID-19 (Row %)	PD	Rate of Death per 1000 PD (95% CI)	n	PWOH With COVID-19 (Row %)	PD	Rate of Death per 1000 PD (95% CI)	Incidence Rate Ratio (95% CI)	
All deceased cases	341	2854	(12)	155 684	2.2 (2.0–2.4)	18 426	245 824	13 873 023	1.3 (1.3–1.3)	1.6 (1.5–1.8)
Sex at birth										
Female	103	796	(13)	43 096	2.4 (2.0–2.9)	7405	121 256	6 922 575	1.1 (1.0–1.1)	2.2 (1.8–2.7)
Male	238	2053	(12)	112 288	2.1 (1.9–2.4)	11 019	124 191	6 927 833	1.6 (1.6–1.6)	1.3 (1.2–1.5)
Missing	0	5	(0)	300	0.0 (NA)	2	377	22 615	0.1 (0–.4)	0.0 (NA)
Age at SARS-CoV-2 diagnosis, y										
13–17	0	2	(0)	120	0.0 (NA)	14	9924	594 509	0.0 (NA)	0.0 (NA)
18–44	20	733	(3)	42 993	0.5 (3–.7)	688	96 151	5 735 719	0.1 (1–.1)	3.9 (2.5–6.1)
45–64	157	1530	(10)	84 964	1.8 (1.6–2.2)	4005	84 573	4 891 757	0.8 (8–.8)	2.3 (1.9–2.7)
65–74	103	441	(23)	21 854	4.7 (3.8–5.7)	4543	28 277	1 482 942	3.1 (3.0–3.2)	1.5 (1.3–1.9)
75+	61	147	(41)	5693	10.7 (8.2–13.8)	9175	26 424	1 138 620	8.1 (7.9–8.2)	1.3 (1.0–1.7)
Missing	0	1	(0)	60	0.0 (NA)	1	475	29 476	0.0 (0–.2)	0.0 (NA)
NYC borough of residence										
Bronx	131	954	(14)	51 423	2.5 (2.1–3.0)	3787	53 436	3 026 593	1.3 (1.2–1.3)	2.0 (1.7–2.4)
Brooklyn	86	663	(13)	35 802	2.4 (1.9–3.0)	5538	70 613	3 969 794	1.4 (1.4–1.4)	1.7 (1.4–2.1)
Manhattan	66	642	(10)	35 407	1.9 (1.4–2.4)	2391	31 831	1 798 557	1.3 (1.3–1.4)	1.4 (1.1–1.8)
Queens	48	518	(9)	28 874	1.7 (1.2–2.2)	5836	73 660	4 142 372	1.4 (1.4–1.4)	1.2 (1.0–1.6)
Staten Island	10	77	(13)	4178	2.4 (1.1–4.4)	874	16 284	935 707	0.9 (9–1.0)	2.6 (1.4–4.8)
Race/ethnicity										
Black, non-Hispanic/Latino	170	1065	(16)	56 054	3.0 (2.6–3.5)	5070	37 307	1 994 783	2.5 (2.5–2.6)	1.2 (1.0–1.4)
Hispanic/Latino	112	764	(15)	40 864	2.7 (2.3–3.3)	5673	49 740	2 718 704	2.1 (2.0–2.1)	1.3 (1.1–1.6)
White, non-Hispanic/Latino	38	295	(13)	16 073	2.4 (1.7–3.2)	4725	40 214	2 186 821	2.2 (2.1–2.2)	1.1 (8–1.5)
Asian, Pacific Islander	2	34	(6)	1966	1.0 (1–4.1)	1411	11 421	617 881	2.3 (2.2–2.4)	0.4 (1–1.8)
Native American or multiracial	15	29	(52)	992	15.1 (8.5–25.0)	893	2078	82 255	10.9 (10.2–11.6)	1.4 (8–2.3)
Unknown	4	667	(1)	39 735	0.1 (0–.6)	654	105 064	6 272 579	0.1 (NA)	1.0 (4–2.6)
Area-based poverty level ^b										
Low, <10% below FPL	24	245	(10)	13 508	1.8 (1.1–2.7)	2562	38 461	2 187 053	1.2 (1.1–1.2)	1.5 (1.0–2.3)
Medium, 10% to <20% below FPL	92	975	(9)	54 272	1.7 (1.4–2.1)	8030	101 076	5 682 178	1.4 (1.4–1.4)	1.2 (1.0–1.5)
High, 20% to <30% below FPL	85	728	(12)	39 903	2.1 (1.7–2.6)	4959	60 816	3 412 476	1.5 (1.4–1.5)	1.5 (1.2–1.8)
Very high, 30%+ below FPL	140	863	(16)	45 481	3.1 (2.6–3.6)	2842	39 181	2 215 564	1.3 (1.2–1.3)	2.4 (2.0–2.8)
Poverty level not available	0	43	(0)	2520	0.0 (NA)	33	6290	375 752	0.1 (1–.1)	0.0 (NA)
At least 1 underlying condition ^c										
Yes	312	1645	(19)	84 475	3.7 (3.3–4.1)	16 074	86 085	4 399 896	3.7 (3.6–3.7)	1.0 (9–1.1)
No known condition	29	1209	(2)	71 210	0.4 (3–.6)	2352	159 739	9 472 200	0.2 (2–.3)	1.6 (1.1–2.4)
Among PWH, baseline HIV viral suppression status ^d										
Virally suppressed	277	2407	(12)	131 715	2.1 (1.9–2.4)	NA	NA	NA	NA	...
No or unknown viral suppression	64	447	(14)	23 739	1.9 (1.2–2.4)	NA	NA	NA	NA	...

Table 3. Continued

Characteristic	COVID-19–Related Death, ^a People With HIV				COVID-19–Related Death, ^a People Without HIV				
	n	PWH with COVID-19 (Row %)	PD	Rate of Death per 1000 PD (95% CI)	N	PWOH With COVID-19 (Row %)	PD	Rate of Death per 1000 PD (95% CI)	Incidence Rate Ratio (95% CI)
Among PWH, baseline CD4 cell count, cells/ μ L ^b									
<200	84	339 (25)	16 709	5.0 (4.0–6.2)	NA	NA	NA	NA	...
200–349	72	415 (17)	21 618	3.3 (2.6–4.2)	NA	NA	NA	NA	...
350–499	52	452 (12)	24 832	2.1 (1.6–2.7)	NA	NA	NA	NA	...
500 +	114	1402 (8)	78 675	1.4 (1.2–1.7)	NA	NA	NA	NA	...
Unknown/no CD4 available	19	246 (8)	13 850	1.4 (1.8–2.2)	NA	NA	NA	NA	...

Data sources include the NYC DOHMH HIV surveillance registry, with data as reported by 30 September 2020, and the NYC DOHMH COVID-19 surveillance system, with case data through 17 October 2020, and outcomes data through 16 December 2020. All demographic data, residence data, and underlying condition data for NYC COVID-19 cases are from the COVID-19 surveillance system. HIV-related clinical variables for PWH are from the HIV surveillance registry.

Abbreviations: n, N, number; CI, confidence interval; FPL, federal poverty level; HIV, human immunodeficiency virus; NA, not applicable; NYC, New York City; PD, person-days; PWH, people with HIV; PWOH, people without HIV.

^aCOVID-19-related death is defined as death date within 60 days after COVID-19 diagnosis date (includes death dates through 16 December 2020).

^bArea-based poverty level is based on NYC ZIP code of most recent residence, per the COVID-19 surveillance system.

^cData on underlying conditions come from the COVID-19 surveillance system, and reflect data available from medical records, patient interview, and registry matches. These data are recorded when available and are not complete for all people diagnosed with COVID-19.

^dViral suppression is based on the most recent HIV viral load at cohort entry, within 12 months. A person is considered virally suppressed if their HIV viral load was <200 copies/mL.

^eBaseline CD4 is based on the most recent CD4 count at cohort entry, within 12 months.

suppression status. NYC DOHMH estimates that there are about 91 000 PWH in NYC [24], with 9% having a most recent CD4 count <200 cells/ μ L [35]. This represents a sizeable population vulnerable to adverse outcomes after SARS-CoV-2 infection. Analysis of COVID-19 vaccination coverage among PWH in New York State revealed concerning low vaccination coverage compared to the general population (63.5% vs 75%, respectively), especially among certain subgroups, including black and American Indian or Alaska Native PWH [36]. Efforts to reduce inequities in COVID-19 vaccination coverage will reduce the disproportionate burden of COVID-19–related hospitalization and death among communities of color and other vulnerable subgroups. Our findings also suggest that providers should have a low threshold for testing PWH for SARS-CoV-2 to identify and treat infection early.

This analysis has several strengths, including its robust methodology and data completeness. Surveillance data provide a comprehensive view of HIV status and COVID-19 outcomes in the NYC population, and have important added value over clinical data sources, which may be subject to selection bias (ie, risk for adverse outcomes may be artificially inflated in a clinically involved population). Additionally, our study included COVID-19 cases and outcomes prior to widespread availability of COVID-19 vaccines and so outcomes were not influenced by a vaccine effect.

Several limitations are also noted. First, COVID-19 laboratory test results, the primary data source, typically contain limited demographic information. Other data sources, including case investigation and clinical data, were used to fill in demographic information but some data, particularly race/ethnicity, were missing. Second, inclusion of confirmed cases only and exclusion of probable cases resulted in an undercounting of COVID-19 cases during this analytic period. Probable cases include those identified by antigen testing and those with symptoms or exposure to a confirmed case, but no laboratory-confirmed diagnosis. While some excluded probable cases were symptomatic, we do not know whether probable cases were more or less likely to have experienced severe outcomes; the impact of their exclusion on our findings is therefore unknown. However, given that point-of-care and at-home rapid testing were less widely available early in the pandemic, confirmed cases should be representative. Third, testing was not consistently available throughout the pandemic, likely resulting in an undercounting of cases earlier on. Due to constraints on the health care system, it is unknown whether these undiagnosed cases were more severe or milder, as even people with severe illness may have not sought treatment. PWH may have been more likely than PWOH to be tested throughout the pandemic, including in the early phases, given their connection with the health care system and potential elevated concerns about SARS-CoV-2. Both the variable availability of testing early in the pandemic, and potential greater access among PWH, could

Table 4. Adjusted Incidence of Adverse COVID-19–Related Outcomes Among People Diagnosed With COVID-19 by HIV Status, NYC, 29 February to 16 December 2020

	COVID-19–Related Hospitalization ^a		COVID-19–Related Death ^b	
	Adjusted Hazard Rate (95% CI) ^c	<i>P</i> Value	Adjusted Hazard Rate (95% CI) ^c	<i>P</i> Value
Diagnosed HIV	REF = PWOH 1.28 (1.2–1.36)	<.0001	REF = PWOH 1.27 (1.14–1.41)	<.0001

Data sources include the NYC DOHMH HIV surveillance registry, with data as reported by 30 September 2020, and the NYC DOHMH COVID-19 surveillance system, with case data through 17 October 2020, and outcomes data through 16 December 2020. All demographic data, residence data, and underlying condition data for NYC COVID-19 cases are from the COVID-19 surveillance system. HIV-related clinical variables for PWH are from the HIV surveillance registry.

Abbreviations: CI, confidence interval; NYC DOHMH, New York City Department of Health and Mental Hygiene; PWH, people with HIV; PWOH, people without HIV.

^aCOVID-19–related hospitalization is defined as hospitalization \pm 14 days from the date of COVID-19 diagnosis.

^bCOVID-19–related death is defined as death date within 60 days after COVID-19 diagnosis date (includes death dates through 16 December 2020).

^cAdjusted for sex at birth, age at SARS-CoV-2 diagnosis, presence of at least 1 non-HIV underlying condition. Data on underlying conditions come from the COVID-19 surveillance system, and reflect data available from medical records, patient interview, and registry matches. These data are recorded when available and are not complete for all people diagnosed with COVID-19.

Table 5. Adjusted Incidence of Adverse COVID-19–Related Outcomes Among People With HIV by Baseline HIV-Related Clinical Status, NYC, 29 February to 16 December 2020

Baseline CD4 cell count, cells/ μ L ^a	COVID-19–Related Hospitalization ^b		COVID-19–Related Death ^c	
	Adjusted Hazard Rate (95% CI) ^d	<i>P</i> Value	Adjusted Hazard Rate (95% CI) ^d	<i>P</i> Value
<200	2.21 (1.87–2.6)	<.0001	2.38 (1.79–3.17)	<.0001
200–349	1.57 (1.33–1.86)	<.0001	1.56 (1.16–2.11)	.0036
350–499	1.45 (1.23–1.73)	<.0001	1.14 (.82–1.59)	.4334
500 +	REF		REF	

Data sources include the NYC DOHMH HIV surveillance registry, with data as reported by 30 September 2020, and the NYC DOHMH COVID-19 surveillance system, with case data through 17 October 2020, and outcomes data through 16 December 2020. All demographic data, residence data, and underlying condition data for NYC COVID-19 cases are from the COVID-19 surveillance system. HIV-related clinical variables for PWH are from the HIV surveillance registry.

Abbreviations: CI, confidence interval; NYC DOHMH, New York City Department of Health and Mental Hygiene; PWH, people with HIV.

^aBaseline CD4 is based on the most recent CD4 count at cohort entry, within 6 months.

^bCOVID-19–related hospitalization is defined as hospitalization \pm 14 days from the date of COVID-19 diagnosis.

^cCOVID-19–related death is defined as death date within 60 days after COVID-19 diagnosis date (includes death dates through 16 December 2020).

^dAdjusted for sex at birth, age at SARS-CoV-2 diagnosis, race/ethnicity, presence of at least 1 non-HIV underlying condition, and HIV viral suppression at baseline. Data on underlying conditions come from the COVID-19 surveillance system, and reflect data available from medical records, patient interview, and registry matches. These data are recorded when available and are not complete for all people diagnosed with COVID-19. Viral suppression based on the most recent HIV viral load at cohort entry, within 6 months. A person is considered virally suppressed if their HIV viral load was <200 copies/mL.

have affected case ascertainment and identification of COVID-19 outcomes, although the direction of those potential impacts is difficult to predict. Fourth, information on underlying conditions is likely incomplete given gaps in clinical data sources. Furthermore, differential ascertainment of underlying conditions among PWH versus PWOH, and among people with COVID-19 who were hospitalized or who died, is possible if these individuals were likelier than their counterparts to have a history of engagement with the health care system and so likelier to have clinical data available. Finally, undercounting of hospitalizations and deaths is possible if data were collected or updated in the surveillance system after 16 December 2020. However, we have no reason to believe outcomes data would have been underascertained differentially for PWH and PWOH and would impact the direction or magnitude of observed associations.

In summary, New Yorkers with HIV experienced elevated risk for poor outcomes from COVID-19 compared to those without HIV during the COVID-19 epidemic in 2020. PWH should be an ongoing focus for vaccination against

COVID-19 and rigorous identification and treatment of new and breakthrough SARS-CoV-2 infections to prevent hospitalization and death due to COVID-19. Work must continue to reduce inequities in the distribution and effects of COVID-19, including among PWH.

Notes

Author contributions. S. L. B., R. L., and A. W. prepared the data, conducted the analysis, and wrote the manuscript.

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